University of Miami Independent System for Peer Review

Review of: *Catching fish, not turtles: pelagic longlines* by John W. Watson, Sheryan P. Epperly, Arvind K. Shah, and Daniel G. Foster

1. EXECUTIVE SUMMARY

Loggerhead turtles (*Caretta caretta*) and leatherback turtles (*Dermochelys coriacea*) are listed by the IUCN as Endangered and Critically Endangered respectively and, consequently, it is important to develop methods of mitigating mortality of these species. One important source of mortality is incidental capture of turtles in longline fisheries and indeed this source of mortality has been implicated in driving leatherback turtles in the Pacific toward extinction (Spotila *et al.* 2000). Couched within this framework, this work sets out to examine whether it is possible to reduce the incidental capture of loggerhead and leatherback turtles in longline fisheries by altering the methods of fishing (hook type and bait). The report details how hook type and bait influenced the capture of target species (swordfish and tuna) and non-target species (loggerhead and leatherback turtles) by longlines in an area of the north western Atlantic known as Northeast Distant (NED) reporting area. It is concluded that by changing the type of hook and the type of bait, the incidental capture of both turtle species can be reduced within the NED with no adverse effect upon the capture rate of the primary target species, swordfish. This is a very important message, as reducing the incidental capture of turtles on longlines is one of the most important conservation actions required to stop population declines. This report details some excellent work and shows clear and striking results that will have major conservation implications. The key recommendation is that by using circle hooks and mackerel, longline fisheries can reduce incidental capture of turtles in the NED area by >55% and will thus meet National Marine Fisheries Service (NMFS) requirements for reopening this fishery to US fishermen. This key recommendation is supported by the results presented.

2. OVERVIEW OF REPORT STRUCTURE

The report is presented in the format of a manuscript to the journal *Science*, with the introduction and key results in the main body of the text and the detailed methods and statistical analysis of results being found in the section entitled "Supporting Online Material". This style is unique to the journal *Science* and provides a constraint on the length of a report. I think the authors should certainly try and publish their results in *Science* as this will ensure this important work has a very wide impact. In the context of reviewing this report, however, there may be some omissions that I have detailed that simply reflect space constraints for manuscripts submitted to *Science*.

3. REVIEW OF METHODS

The Methods provides a comprehensive account of the types of hook and baits used and the experimental design. The control group consisted of 20-25° offset "J" hooks with squid bait (the industry standard) while four experimental treatments were used: 0° offset circle hooks with squid bait, 10° offset circle hooks with squid bait, 20-25° offset "J" hooks with mackerel bait and 10° offset circle hooks with mackerel bait. The experimental design was very good with alternating control and experimental hooks on each longline section and only one bait type on each set.

A total of 489 research sets were made in the NED area, with a total of 427,385 hooks. This is a very comprehensive sample size and the authors clearly show how this sample size is large enough to detect effects of gear type, i.e. the chances of missing a real effect because of an insufficient sample size (a Type 2 statistical error) are small. The data analysis is generally strong (but see sections below on effect of Sea Surface Temperature), with appropriate use of statistics and sound interpretation of the results.

4. REVIEW OF RESULTS

The key Results are very clearly presented with hook and bait type both having very clear impacts on catch rates of turtles, swordfish and tuna. In short, compared to the traditional "J" hook and squid bait, using either circle hooks and/or mackerel bait caused a large and significant reduction in the incidental capture of both loggerhead and leatherback turtles with this reduction in incidental capture exceeding the 55% reduction required by the NMFS for this fishery to be reopened to US fishermen. While this key finding and recommendation is solid and supported by the results I do, however, have some comments on the interpretation of catch rates versus sea surface temperature and the need to include some information on the depth of fishing – see points 4.3 and 4.4.1 below.

4.1 Gear interaction/hooking location

In terms of hooking location, the most striking finding is that with "J" hooks most loggerheads were hooked internally, while with "circle" hooks most loggerhead were

hooked in the mouth. With leatherback turtles, most were entangled or foul-hooked regardless of the hook type. These results are well presented and appropriately analysed.

4.2. Catch Rates

The catch results are very clearly presented and the statistics used are robust. A very clear and striking finding is shown: by not using "J" hooks baited with squid, the incidental capture of turtles is greatly reduced. Instead by using either "J" hooks baited with mackerel or "circle" hooks baited with either squid or mackerel, the incidental rate of capture of turtles is greatly reduced. In addition to the large effect of hook and bait type of turtle capture rates, sea surface temperature also had an important effect on turtle capture rates (more captured at warmer temperature).

4.3. Sea surface temperature (SST)

The affect of SST is slightly suspect without the presentation of further material. How is SST measured? At the moment the report states simply that SST was recorded, but there are no details of **how** the measurement was made and levels of accuracy and precision. Also the text refers to degrees Celsius but there is also mention of degrees Fahrenheit (Methods and Table S1). As I understand, measurements were made in degrees Fahrenheit and then subsequently changed to degrees Celsius for presentation in the Results. Is this correct? The report details a strong effect of water temperature on the catch rates for both loggerhead (p.7) and leatherback turtles (p.9) and then elsewhere (Conclusions, p.13) suggests that one way of reduced incidental capture of turtles would be for fishermen to target colder waters. As it stands, I am unconvinced by this data analysis and think that a more careful consideration of seasonal versus mesoscale affects needs to be considered. Within the NED, there will be a seasonal change in SST, with maximal temperatures, I suspect, around September. Turtles are seasonally abundant at high latitudes. For example, satellite tracking has shown that at the end of the summer, leatherback turtles migrate southward from northern latitudes, probably in response to cooling SSTs. Therefore, the effect of SST on turtle capture rates may reflect their seasonal patterns of occurrence within the NED. This is quite different to a mesoscale effect of turtles inhabiting warmer water versus cooler water in the same month, i.e. specifically targeting their fine scale foraging activities in certain water masses at the mesoscale level. Therefore I think that it is important that the seasonal timing of turtle captures is considered and more analysis is needed to tease apart possible seasonal versus mesoscale influences on turtle distribution.

4.4 Omission of information from Results

4.4.1 Depth of hooks?

The depth of hooks will be vitally important in determining incidental catch rates. A large data-base is currently being accumulated on leatherback and loggerhead patterns of diving. Yet this report contains no mention whatsoever of the depth at which hooks were fished. This information is very important to include and presumably this information was recorded during the study. How did the depth of hooks vary between sets, hook types, bait types etc. etc. The lack of details on depth of hooks is an important omission from this report.

4.4.2 Measuring the size of turtles

The size of turtles was either measured directly (for loggerhead turtles taken onboard) or estimated (leatherback turtles). For the estimated size of leatherbacks, I think it would have been useful if the authors had conducted some validation exercises for how well they could estimate size. This has been done before for turtles and other marine vertebrates (e.g. Houghton *et al.* 2003). By making models of different sizes, observers could be tested so that their "estimated" size can be directly compared to the actual size. Alternatively for any leatherback brought on-board a direct comparison could be made between remotely estimated size and directly measured size. Either of these validation exercises would provide more confidence in the leatherback size data.

4.4.3 Conclusions to be drawn from turtle size data

I think there are some very useful conclusions that could be drawn from the size data. The size of captured loggerheads (32-68 cm) is smaller than the size of adult females recorded nesting on the Atlantic costs of the USA. So these longline captured turtles are immature. In contrast, captured leatherbacks are broadly the same size as females observed nesting in the Caribbean and South America, i.e. the captured leatherbacks are probably mostly adults. These conclusions have important conservation implications, as mortality of one juvenile does not equate to mortality of one adult. I think that more explicit mention of the likely developmental stage of the loggerheads and leatherbacks would be a useful addition to this report.

5. MINOR EDITORIAL POINTS

p.3, first line. "roaming". For many species (e.g. hawksbills and greens) the adults spend most of their time in residence of very small costal home-ranges and so this terminology is not justified.

p.3, first line. "listed". All seven species are "listed" but for only 6 of the 7, is the listing critically endangered or endangered. The seventh (flatback turtle) has a listing of "data deficient"

p.3, end of first paragraph. Species name for the swordfish is "*gladius*" not "*gladis*"

6. RECOMMENDATIONS FOR FUTURE WORK

I have two important recommendations for future work.

6.1. Post-release survival

One important consideration in this report is the survival rate of turtles released after being caught in various ways (hook in mouth, oesophagus, stomach; entangled in line etc.). For example it is suggested (p.8) that swallowing hooks is "probably the most lethal form of interaction". This suggestion is reasonable but could be tested directed. Similarly

it is suggested (p.10) that "Removal of gear is expected to increase post-hooking survival". Again this could be tested directly. Intuitively I would suspect that removing gear is a good thing if it can be done without causing major trauma to the animal. In order to directly examine post-release survival, telemetry equipment could be attached to some animals. Specifically, advanced satellite tags are now available that can reveal not just the position of animals but also aspects of their behaviour such as their diving behaviour and swim speed (Fedak *et al.* 2002). Such tags can directly reveal capture of turtles by fishermen, e.g. by the transmitter coming out of the water and/or moving inland (Hays *et al.* 2003). In some cases a turtle might die post-release and sink to the seabed rather than float. To record such an event satellite tags can be attached in such a way that they release after a certain pressure (i.e. depth) is attained. So it is possible to record the post release behaviour of turtles in great detail and I believe this type of work is already being conducted, to some extent, in the Pacific. A logical development for work in the western Atlantic is to examine the post-release behaviour of turtles.

6.2. Overall pattern of habitat use by turtles in the North Atlantic

The report clearly identifies the rate of capture of turtles in the NED area of the western Atlantic. It is important to define the overall use of this area by leatherback turtles. For example, if only 1 in 1,000 adult leatherbacks in the Atlantic ever enters this area, the conservation issues in the NED will be unimportant for the overall survival of this species. However, if a high proportion of individuals enter the NED, then the conservation measures being implemented will have very far reaching consequences.

There is already some work underway to address this issue. By attaching satellite transmitters to nesting females, it is now possible to record their movements for extended periods (up to one year or more). Two European groups (one French , one Welsh) have each tracked about 10 turtles for long periods (many months) and these studies point to the NED area being important for leatherbacks turtles, with a high proportion of tracked turtles entered this area. These initial studies need to be expanded so that the overall importance of the NED can be assessed.

7. REFERENCES

Fedak M, Lovell P, McConnell B, Hunter C (2002). Overcoming the constraints of long range radio telemetry from animals: Getting more useful data from smaller packages. *Integrative and Comparative Biology* **42**, 3-10.

Hays GC, Broderick AC, Godley BJ, Luschi P, Nichols WJ (2003). Satellite telemetry suggests high levels of fishing induced mortality for marine turtles. *Marine Ecology Progress Series* **262**, 305-308.

Houghton JDR, Callow MJ, Hays GC (2003). Habitat utilisation of juvenile hawksbill turtles (*Eretmochelys imbricata*) in a shallow water coral reef habitat. *Journal of Natural History* **37**, 1269-1280.

Spotila JR, Reina RD, Steyermark AC, Plotkin PT, Paladino FV (2000). Pacific leatherback turtles face extinction. *Nature* **405**, 529-530.

8. APPENDICES

a. Bibliography of all work provided.

Watson, J. W., S. P. Epperly, A. K. Shah, and D. G. Foster. 2004a. Catching fish, not turtles: Pelagic longlines. 15 pp. + 1 table & 4 figures.

Watson, J. W., S. P. Epperly, A. K. Shah, and D. G. Foster. 2004b. Supporting online material for Catching fish, not turtles: Pelagic longlines. 10 pp. + 4 tables & 7 figures.

b. Statement of Work

Statement of Work

Consulting Agreement between the University of Miami and The University of Wales

January 29, 2004

General

Incidental capture of sea turtles in fisheries is one of the most significant threats to their survival and recovery. Possible management measures addressing the incidental take and mortalities of endangered and threatened sea turtle species by U.S. pelagic longline fisheries are derived from research to design, develop, and evaluate gear and/or tactical measures capable of significantly reducing the interaction between sea turtles and longline fishing gear. In 2001, NOAA Fisheries initiated a three-year cooperative research program in the western Atlantic Ocean to develop and evaluate fishing technology and tactics to reduce the incidental capture and mortality of sea turtles by pelagic longline gears. This research program was successful in developing fishing techniques that significantly reduce the interaction of both loggerhead (*Caretta caretta*) and leatherback sea turtles (*Dermochelys coriacea*) with pelagic longline gear and tools and techniques to remove gear from the turtles that do interact with the gear. NOAA Fisheries is proposing rule making to require the use of this gear by U.S. pelagic fishers in the southeastern United States.

Pelagic longline fleets of other nations comprise over 90% of the longline fishing effort in the Atlantic. A major emphasis of the U.S. gear development research effort will be to transfer successful technology and encourage the use of practical measures to reduce sea turtle interactions by foreign fleets.

In order to provide information for rule making and technology transfer to other nations, a draft manuscript has been prepared, titled, '*Catching fish, not turtles: Pelagic longlines'*, by John W. Watson, Sheryan P. Epperly, Arvind K. Shah, and Daniel G. Foster. There is an urgent need for independent peer review of the manuscript in order to meet hard deadlines for rule making and to expedite transfer of the research results to other countries.

Specific

The consultant shall conduct an in-depth review of the manuscript and provide a written professional evaluation of the quality of the research, data analysis, statistical procedures, and conclusions contained in the manuscript.

The consultant shall review the experimental design and data analysis and provide written comments on whether the data and data analysis support the conclusion that the treatments tested significantly reduce the interaction of sea turtles with pelagic longline gear under the conditions tested. Specifically, the consultant shall provide written evaluation of the appropriateness of the experimental design, the appropriateness of the statistical procedures used in the analyses of the data and whether the data and analyses support the conclusions. The consultant will also provide comments on additional research needed if appropriate.

The consultant's tasks, which will take a maximum of three days, shall consist of:

1. Conducting an in-depth review of the manuscript and providing a written professional evaluation of the quality of the research, data analysis, statistical procedures, and conclusions contained in the manuscript;

2. Completing a written report (See Annex I) no later than February 13, 2004 and submitting it to "University of Miami Independent System for Peer Review" and sent to Dr. David Sampson, via email to david.sampson@oregonstate.edu and to Mr. Manoj Shivlani, via email to mshivlani@rsmas.miami.edu.